SAFEGUARDING SPECIES, LANGUAGES, AND CULTURES IN THE TIME OF DIVERSITY LOSS: FROM THE COLORADO PLATEAU TO GLOBAL HOTSPOTS[1]

Gary Paul Nabhan,[2] Patrick Pynes,[2] and Tony Joe[2]

ABSTRACT

Hotspots of biodiversity have become priority areas for land conservation initiatives, oftentimes without recognition that these areas are hotspots of cultural diversity as well. Using the Colorado Plateau ecoregion as a case study, this inquiry (1) outlines the broad geographic patterns of biological diversity and ethnolinguistic diversity within this ecoregion; (2) discusses why these two kinds of diversity are often influenced by the same geographic and historic factors; and (3) suggests what can be done to integrate traditional ecological knowledge of indigenous peoples into multicultural conservation collaborations.

Key words: biodiversity, conservation planning, linguistic diversity, traditional ecological knowledge.

"Along come the scientists and make the words of our ancestors into folklore."

—Agnon (1966)

"The diversity of life on earth is under threat; so is the diversity of human cultures. . . . The intriguing question is this: apart from establishing rights over resources, will the local communities bring back some of their earlier cultural traditions of conservation of biological diversity?"

—Gadgil (1987)

The Colorado Plateau of North America (Fig. 1)[3] has received international recognition for nearly a century because of the pioneering efforts there to formally protect its spectacular natural and cultural landscapes (Sellars, 1997). Despite that recognition, the region's resource managers and conservationists have yet to work with much understanding of how biological and cultural diversity have interacted within this four-state area. Since the establishment of Mesa Verde National Park in 1906 and the Grand Canyon National Park in 1919 (Burnham, 2000), more than 11.1 million acres of the Colorado Plateau's 130 million acres have been federally protected for their natural and cultural resources. A diverse collection of national parks and monuments, wildlife refuges, recreation areas, conservation areas, preserves, wilderness areas, and national historic parks and sites, these protected lands are managed by the National Park Service, the U.S. Fish and Wildlife Service, the U.S. Forest Service, and the Bureau of Land Management (Tables 1 and 2). Conservation efforts on the Colorado Plateau were initiated long before our belated recognition that the ecoregion harbors a remarkably high diversity of plants, butterflies, tiger beetles, and mammals compared to 109 other ecoregions of similar size in North America (Ricketts et al.,

[1] We are grateful for the support of the Arizona Community Foundation, the Town Creek Foundation, the Ottens Foundation, and Agnese Haury, all of whom enabled this synthesis. Our manuscript was greatly improved as a result of comments from Victoria Hollowell, our Flagstaff colleagues Larry Stevens and Tom Sisk, David Armstrong, and two anonymous reviewers. The numerous participants in the NAU/Terralingua-sponsored retreat, "Bridging Ecological Restoration and Linguistic Revitalization on Indian Reservations on the Colorado Plateau," have greatly influenced our thinking. In particular, we thank Vernon Masayesva, Ferrel Sekakaku, Luisa Maffi, David Harmon, and Steve Albert. Laverne Masayesva Jeanne and Donna House have also offered us guidance and insight into issues particular to the Hopi and Navajo, respectively. Aimee Goodwin was responsible for GIS analyses in ARC-VIEW, and together with Dan Boone and Ron Redsteer, kindly assisted us with maps.

[2] Center for Sustainable Environments, Northern Arizona University, Flagstaff, Arizona 86011, U.S.A.

[3] As far as we are concerned, an "objective" definition of the Colorado Plateau does not exist. Different researchers draw the Plateau's boundaries differently, but most agree that the Plateau's geographic heart is located in the Four Corners region, where the states of Arizona, Utah, Colorado, and New Mexico intersect. The three figures included in this essay show two different boundaries of the Colorado Plateau, especially along the northeastern margin. For the purposes of statistical analysis (of the total area of Indian lands versus federally protected lands, etc.) in this study, we used the Colorado Plateau boundary outlined in Figure 3. The boundary shown in both Figures 1 and 2 is an "alternative" delineation.

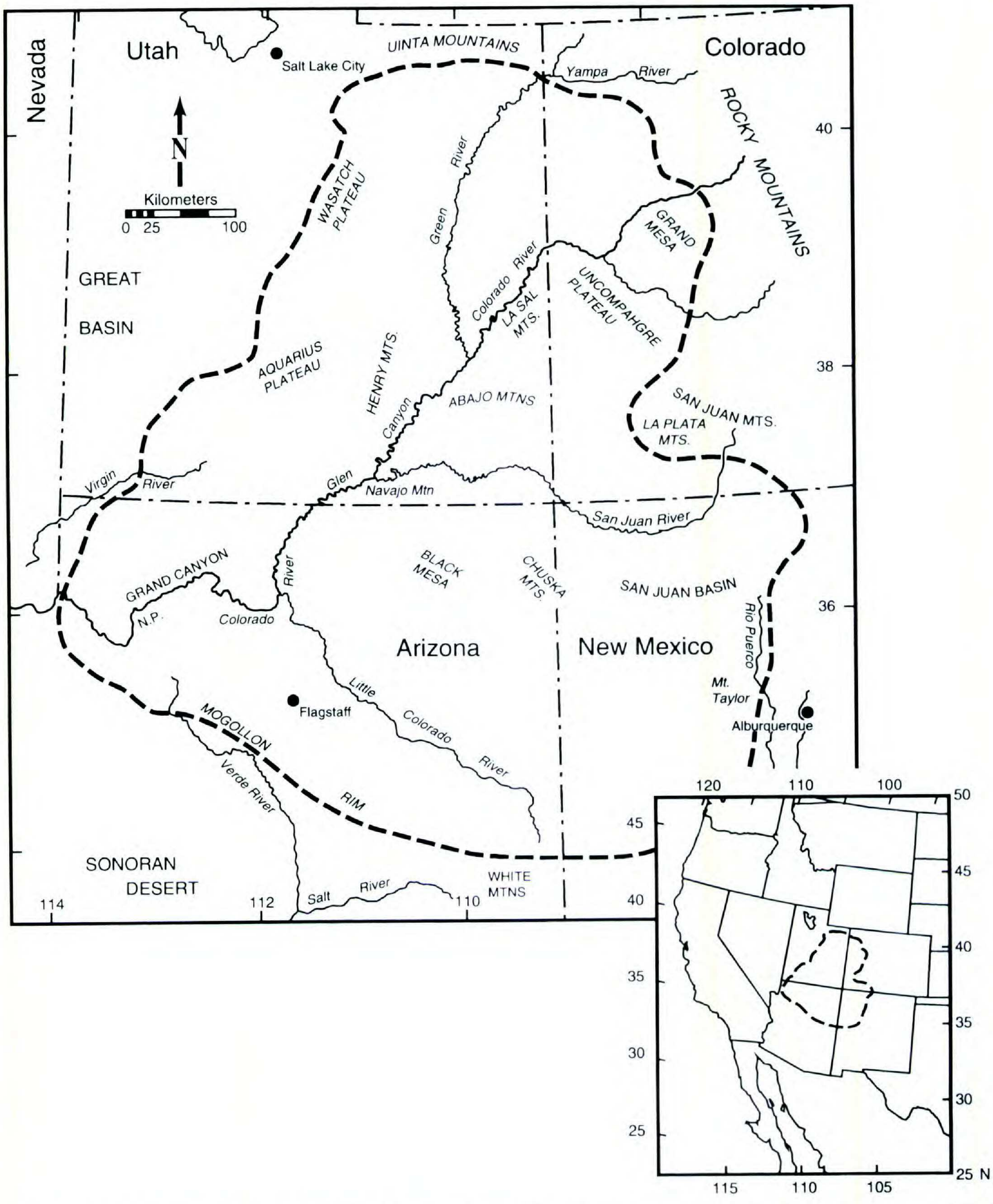

Figure 1. Boundary of the Colorado Plateau. For additional maps, articles, and photographs, see ⟨http://www.cpluhna.nau.edu/index.htm⟩.

1999a, 1999b). Although recent National Monument designations such as the Grand Staircase/Escalante have, in fact, taken into account the area's biodiversity and rich cultural heritage, these two factors have rarely been conceptually linked. More typically, they have been offered as "twin" attractions for ecotourists intrigued by redrock landscapes. Indeed, the 8 and 10 million tourists who annually visit national parks and monuments on the Plateau may receive some unanticipated exposure to this biodiversity and the ancient cultural influences upon it, but that is seldom what attracted

Table 1. National parks of the Colorado Plateau. Source: National Park Service website (http://www.nps.gov)

Park	State	Acreage
Arches	Utah	76,518
Black Canyon of the Gunnison	Colorado	27,705
Bryce	Utah	35,845
Canyonlands	Utah	337,597
Capitol Reef	Utah	241,904
Grand Canyon	Arizona	1,217,403
Mesa Verde	Colorado	52,121
Petrified Forest	Arizona	93,533
Zion	Utah	146,592
9 National Parks	2 in AZ; 2 in CO; 5 in UT	2,229,218 total acres (2.3 million acres)

them to the parks and monuments of the Painted Desert or Canyonlands in the first place.

Because about 13.5 percent of the Colorado Plateau's landmass is already protected by federal agencies, the ecoregion's extant biodiversity has not been considered as gravely imperiled as the biodiversity of other regions of North America. Nevertheless, our recent (unpublished) survey of more than 70 environmental professionals (including Native Americans) working on the Plateau indicates that this ecoregion remains unusually vulnerable to threats such as the damming of rivers; oil, gas, coal, uranium, and aquifer mining; competition from invasive species; mismanagement of wildfire regimes; and the fragmentation of wildland habitats by rapidly increasing urbanization. Such threats continue to diminish native biodiversity, both within and beyond national parks. The Nature Conservancy (TNC) has therefore ranked the Colorado Plateau within the third tier of hotspots of imperiled biodiversity. At the same time, TNC recognized that this ecoregion's "rarity-weighted species richness"

Table 2. National monuments of the Colorado Plateau. Source: National Park Service and Bureau of Land Management websites (http://www.nps.gov) and (http://www.blm.gov.)

Name	State	Managing agency	Acreage
Aztec Ruins	New Mexico	NPS	319
Canyon de Chelly	Arizona	NPS (leased from Navajo Nation)	83,840
Canyons of the Ancients	Colorado	BLM	164,000
Cedar Breaks	Utah	NPS	6,154
Colorado	Colorado	NPS	20,453
Dinosaur	Utah	NPS	210,277
El Malpais	New Mexico	NPS	114,277
El Morro	New Mexico	NPS	1,278
Grand Canyon-Parashant	Arizona	BLM	1,014,000
Grand Staircase-Escalante	Utah	BLM	1,900,000
Hovenweep	Utah	NPS	784
Montezuma Castle	Arizona	NPS	857
Natural Bridges	Utah	NPS	7,636
Navajo	Arizona	NPS (leased from Navajo Nation)	360
Pipe Spring	Arizona	NPS	40
Rainbow Bridge	Utah	NPS	160
Sunset Crater Volcano	Arizona	NPS	3,040
Tuzigoot	Arizona	NPS	40
Vermilion Cliffs	Arizona	BLM	293,000
Walnut Canyon	Arizona	NPS	3,579
Wupatki	Arizona	NPS	35,422
Yucca House	Colorado	NPS	33
22 National Monuments	10 in AZ; 3 in CO; 3 in NM; 6 in UT	BLM and NPS lands	3,859,549 total acres

was considered more significant and less well-known than it deserved to be (Stein et al., 2000); in other words, the Colorado Plateau harbors many biological rarities whose vulnerability to threats has not yet been adequately assessed. Consider the fact that the relatively well endowed Grand Canyon National Park has continued to lose an average of one species per year during the last two decades; the park's current research budget and resource management strategies have somehow not been sufficient to prevent the local extirpation of rare species.

Putting aside for the moment the degree to which current threats imperil the ecoregion's biota, it is clear that the Colorado Plateau is indeed rich in such rarities, including *endemic* species (that is, species with narrow distributions that occur in this ecoregion and nowhere else). Continent-wide floristic analyses by Kartesz and Farstad (1999) have affirmed that the Plateau is the ecoregion of continental North America with the highest rate of vascular plant endemism, reporting 290 species restricted to this ecoregion. For the fauna of the Colorado Plateau ecoregion, David Armstrong (in prep.) has recently determined that 23.6 percent of the mammals and 36 percent of the rodents exhibit endemism at the levels of species or subspecies.

While appreciation of the Plateau's biological uniqueness has grown, recognition of its cultural and linguistic uniqueness still lags far behind. The Colorado Plateau is home to more speakers of Native American languages than all other regions in the United States combined. The ecoregion's indigenous peoples belong to 24 different tribes, bands, or dialect communities and represent six different language families (Table 3).[1] (English, of course, as well as Spanish and Basque are also spoken here.) Among the Plateau's indigenous languages, Zuni is a language isolate, or what biologists might call an "endemic" language of the Colorado Plateau. According to many linguists, Zuni (*a:shiwi*) has no close relative in any other language family (Campbell, 1997). In addition to Zuni, the other language families indigenous to the Colorado Plateau include Keres, a family represented by Acoma Pueblo, Laguna Pueblo, and Zia Pueblo; Kiowa-Tanoan, the language family represented at Jemez Pueblo; Uto-Aztecan, the language family to which the Hopi, Ute, and Paiute languages belong; Athabaskan, represented by the Apache and Navajo languages; and Yuman, represented by the Yavapai, Havasupai, and Hualapai tribes on the Colorado Plateau. Figure 2 shows the approximate geographic boundaries of these six indigenous language families in 1850, when the Colorado Plateau officially became part of U.S. territory. Tribes and communities who spoke (speak) a language that belongs to one of the six families were living in these areas at that point in time. For example, Navajo and Apache speakers occupied the lands shown as "Southern-Athabascan" on this historical map.

The Colorado Plateau undoubtedly ranks among the top five American regions north of the Tropic of Cancer in terms of linguistic, cultural, and biological diversity, as well as in biological and linguistic/cultural endemism. Nevertheless, there is not a single conservation plan that takes into account both the cultural diversity and the biological diversity of the region. It is as if the historic and geographic relationships between "nature" and "culture" on the Plateau are somehow irrelevant, or too hotly debated to be of value in conservation planning. While it may be reasonable for conservation planners to be skeptical of painting all Native American land and water management practices as "ecologically noble," it is also tragic that so few Native American communities have been involved in planning national parks and monuments adjacent to their current reservations. These federal lands were clearly parts of their historic homelands (Burnham, 2000). As a result, the management of cultural resources and the management of natural resources have typically been done by different sets of specialists, sometimes involving Native Americans in the former but nearly always ignoring their traditional ecological knowledge of the latter.

This historic failure of the vast majority of conservation biologists and environmentalists to substantively engage Native American communities in collaborative work based on shared goals is both disappointing and ironic. It is ironic because the long-term residents of the Colorado Plateau have substantial knowledge about the history of the local flora and fauna that is not available from other sources. Even if all their current hunting, foraging, or farming practices are not considered to be ecologically benign by conservation biologists (Diamond, 1993), this does not negate the value of their traditional ecological knowledge (as defined by Berkes, 2000) about factors influencing plant and animal distributions, densities, and vulnerabilities. [Incidentally, Diamond's (1993) widely cited condemnation of prehistoric peoples of the Colorado Plateau for deforesting the Chaco Canyon area to obtain timber to build multi-storied pueblos has been refuted by recent strontium isotope evidence

[1] The numerous sources for Table 3 are found in the Literature Cited, and each source is preceded by an asterisk (*).

Table 3. Status of the Colorado Plateau's indigenous languages. Note: Sources for this chart are shown in the References section. Each source is preceded by an asterisk (*).

Tribe, band, or community	Total tribal landbase (acres)	Language or language subgroup	Language family affiliation	Total enrolled tribal members	Approximate percentage of fluent native speakers	Approximate percentage of fluent native speakers, ages 2–18
Jicarilla Apache	879,605	Apache	Eyak-Athabaskan	3,500	23%	<2%
Tonto Apache	85	Apache	Eyak-Athabaskan	110	30%	0%
White Mountain Apache	1,600,000	Apache	Eyak-Athabaskan	15,000	50%	13%
Alamo Navajo	63,000	Apache	Eyak-Athabaskan	2,000	95%	90%
Navajo Nation	17,000,000	Navajo	Eyak-Athabaskan	259,556	57%	<50%
Ramah Navajo	146,953	Navajo	Eyak-Athabaskan	2,463	60%	5%
Tóhajiileehé (Cañocito Band of Navajos)	80,000	Navajo	Eyak-Athabaskan	2,382	75%	50%
Havasupai	188,077	Pai	Cochimi-Yuman	639	98%	90%
Hualapai	1,000,000	Pai	Cochimi-Yuman	2,100	30%	<25%
Camp Verde Yavapai-Apache	636	Pai & Apache	Cochimi-Yuman & Eyak-Athabaskan	1,675	<2%	<2%
Yavapai-Prescott	1,395	Pai	Cochimi-Yuman	158	<2%	<2%
Kaibab Band of Paiute Indians	120,431	Southern Paiute	Uto-Aztecan	240	<2%	0%
Paiute Tribe of Utah	36,000	Southern Paiute	Uto-Aztecan	753	<2%	0%
San Juan Southern Paiute	5,000	Southern Paiute	Uto-Aztecan	300	75%	10%
Southern Ute	313,288	Ute	Uto-Aztecan	1,316	15%	5%
Uintah Ouray Ute	4,500,000	Ute	Uto-Aztecan	3,500	33%	<33%
Ute Mountain Ute	606,218	Ute	Uto-Aztecan	2,000	54%	2%
Acoma Pueblo	378,262	Western Keres	Keresan	6,344	50%	2%
Laguna Pueblo	491,387	Western Keres	Keresan	7,696	30%	2%
Hopi Pueblo	1,542,306	Hopi	Uto-Aztecan	10,916	48%	<8%
Hano (Hopi Tewa)		Tewa	Kiowa-Tanoan	600	65%	<2%
Jemez Pueblo	89,619	Towa	Kiowa-Tanoan	3,083	75%	50%
Zia Pueblo	117,000	Eastern Keres	Keresan	773	70%	<2%
Zuni Pueblo	463,270	Zuni	Zuni (no known relatives)	9,690	66%	60%
24 district tribes, bands, or communities in four different states	29,622,532	10 languages	6 language families	335,782		

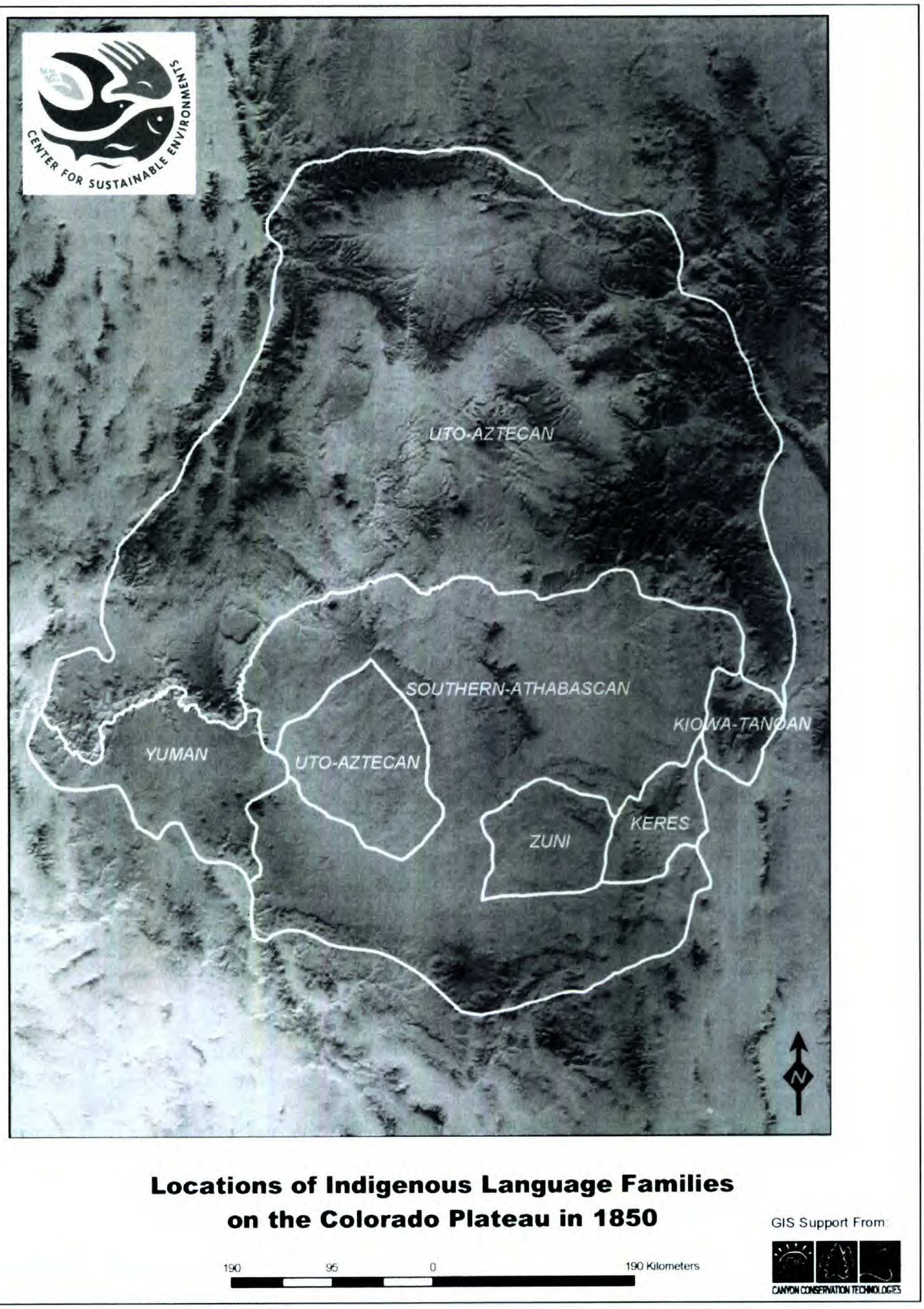

Figure 2. Locations of indigenous language families on the Colorado Plateau in 1850. (From data developed by the Center for Sustainable Environments.)

that the Chaco Anasazi obtained their ponderosa and spruce/fir beams by cutting a single age class of trees selected from two large mountain ranges 50–75 miles away (English et al., 2001).| Indeed, the more pertinent question is whether the traditional ecological knowledge of Plateau tribes is being lost at such a rapid rate that it will no longer be of service in biological conservation (Nabhan,

ligations (L. Masayesva Jeanne, in Nabhan & Reichhardt, 1983).

Traditional ecological knowledge can also be useful in locating and staging rare species reintroductions and habitat restoration. At a time when the California Condor recovery efforts in California were on the verge of failure, Rea (1981) proposed that the recovery team broaden its view and consider reintroductions in the historic refugium near the Colorado River's Grand Canyon, where oral histories from the Hopi recall sightings of the giant bird they call *kwaatoko* (Whiting unpublished, in Seaman, 1993). This has, in fact, turned out to be one of the more successful areas for Condor reintroduction, even though it is outside of California where many biologists erroneously presumed that the California Condor belonged (Rea, 1981).

Investment in Conservation Capacity-Building for Native Americans Remains Critical

For decades, the Bureau of Indian Affairs hardly involved Native Americans in so-called technical decisions regarding biological resource and land management options on tribal lands. While the number of Native Americans trained in biology and nature resource management increased fivefold between 1970 and 1999, there remains a chronic underinvestment in training Native American professionals in biodiversity conservation on tribal lands relative to the training available for professionals managing federal lands. The Navajo Natural Heritage Program, first sponsored by The Nature Conservancy, has become an outstanding example of the "conservation pay-off" of such investment (Stein et al., 2000). The Hopi, Zuni, and White Mountain Apache tribes have also developed programs that include wildlife management, endangered species recovery, and ecological restoration. In the case of the Zuni, their program to reintroduce beavers as part of the tribe's riparian restoration efforts has involved elders teaching youth about the cultural significance of beavers and other wetland dwellers (Albert & Trimble, 2000). When both Western academic and traditional ecological knowledge are valued by such programs, it ensures that Indian youth interested in natural history are not forced to choose between their own cultural way of looking at the natural world, and the way of modern science. One superlative example of such capacity-building efforts among Native Americans is the EPA-funded Institute for Tribal Environmental Professionals based at Northern Arizona University, which has already trained more than 500 tribal members from over 200 communities in inventory, monitoring, and restoration techniques for environmental protection.

More Linkages Are Needed Between Ecological Restoration and Linguistic Revitalization

In addition to the many ecological restoration projects recently initiated on tribal lands, most Native American communities on the Colorado Plateau are actively engaged in language stabilization and revitalization efforts (Cantoni, 1996). These language restoration projects often include the elaboration of the entire extant lexicon of a tribe, including its names for plants, animals, and their habitats. In eliciting these names, linguists often do not know the particular scientific taxa the words are describing, but nevertheless record ecological information that may be of use to ecological restoration and species recovery projects (Nabhan, 2000a). For instance, the Diné name for the Indian paintbrush, *Castilleja lanata* A. Gray, is *dah yiitihidaa tsoh*, meaning "big hummingbird's food," to distinguish it from the beardtongue, *Penstemon barbatus* (Cav.) Roth, called *dah yiitihidaa'ts'ooz*, or "food of the slender hummingbird." It may be that Diné elders recognize that these two flowers are frequented by different sizes and species of hummingbirds, and that such information can be integrated into ecological restoration efforts to increase forest understory biodiversity.

Conclusions: Implications for Global Conservation Strategies

Over the last decade, tremendous effort has gone into defining, locating, and rapidly assessing the species richness of "hotspots of biodiversity" (Mittermeier et al., 1998; Olson & Dinerstein, 1998; Ricketts et al., 1999a). By some accounts, these hotspots not only capture a large proportion of the planet's biodiversity, but they also define an agenda for conservation investment, which is largely expended on land purchases and infrastructure development for protected areas (Mittermeier et al., 1998). By investing an average of $40 million/year on land purchases in hotspots, rather than on the current "scattergun" approach of current conservation expenditures, these conservation strategists have proposed a new "silver bullet" to biodiversity loss that could protect areas containing a high proportion of the world's species, while business outside the hotspots could be allowed to go on as usual.

Ehrenfeld (in press) has pointed out the serious

2000a). To date, this rapidly disappearing orally transmitted knowledge has rarely been systematically taken into account and valued by land managers, who often consider such knowledge to be the quaint but anecdotal or superstitious recollections of scientifically untrained old-timers.

Even contemporary Native Americans' roles in managing the lands of the Colorado Plateau have been chronically underestimated. While the Grand Canyon Trust considers "Indian country" to comprise just a quarter of the Colorado Plateau's 130 million acres (Hecox & Ack, 1996; Wilkinson, 1999), our GIS-based analyses more accurately establish that 29–32% of the Colorado Plateau is being managed by Native American communities (depending upon which definition of the Plateau's boundaries is used). By virtue of this fact alone, it would be presumptuous if not impossible to develop a systematic conservation plan for this ecoregion that did not take into account Native American land stewardship and traditional ecological knowledge of endangered species on the Colorado Plateau (Nabhan, 2000a, b).

In a modest effort to begin to bridge the historic gap between studies of biological and cultural diversity, Northern Arizona University's Center for Sustainable Environments (CSE) has initiated a pilot study with the Grand Canyons Wildlands Council to assess ways to better safeguard and restore both the biological and the cultural uniqueness of the Colorado Plateau. In designing this pilot study, we have investigated the potential linkages between biological and linguistic diversity elucidated by the scholars involved in "Terralingua: Partnerships for Linguistic and Biological Diversity," an international non-profit organization hosted by CSE, which has recently published a global analysis of biocultural diversity (Maffi, 2001). The following discussion emphasizes why efforts to conserve biological and linguistic diversity should be linked, whenever possible, using examples from the Colorado Plateau.

The Biodiversity on Native American Lands Deserves More Conservation Investment

Indian reservations in the United States cover tens of millions of acres of the North American continent, comparable in extent to the acreage that the National Park Service manages for North America's biodiversity. In particular, reservation lands on the Colorado Plateau (Fig. 3) cover nearly twice the area that national parks, monuments, preserves, conservation areas, wilderness areas, and wildlife refuges cover in the same ecoregion. Nevertheless, the 29.6 million acres of lands managed by Native Americans on the Colorado Plateau have yet to receive much investment from federal or private sources for the inventory of their biodiversity, monitoring, and recovery of their rare species, or local capacity-building in environmental protection—relative to the considerable support given to those working on adjacent federally protected lands.

If all the species found on Indian lands were also found on lands rigorously protected by the National Park Service or The Nature Conservancy, perhaps this issue would be easier for conservation biologists to ignore. However, the narrowly distributed endemics of the region are often restricted to habitats found only on reservation lands, and not on park lands. The Navajo sedge, *Carex specuicola* J. T. Howell, is an endangered species found around only three springs and seeps used by Diné (Navajo) livestock herders, and one spring used by Hopi farmers. In other words, its range is restricted to the Navajo and Hopi Reservations (D. House, pers. comm.; Nabhan et al., 1991). Similar situations occur for the endemic Hopi chipmunk (*Tamias rufus*), a subspecies of the Spotted Ground Squirrel (*Spermophilus spilosoma cryptospilotus*), the Chuska and Tunitcha Mountain subspecies of Abert's squirrel (*Sciurus aberti chuskensis*), and a subspecies of Stephen's woodrat (*Neotoma stephensi relicta*) found only on Navajo lands. Even if conservation biologists continue to feel ill-equipped to deal with the cultural and legal (sovereignty) issues regarding plants and animals restricted to tribal lands, they can no longer ignore the fact that the only means to sustain these species is by providing Native American land managers with the resources needed to protect or recover these rare populations and their habitats.

The Conservation Community Needs to Embrace Traditional Ecological Knowledge

Until recently, endangered species recovery teams and ecological restorationists disregarded the traditional ecological knowledge found in Native American communities. Perhaps the first formal breakthrough occurred when Diné biologist Donna House incorporated traditional ecological and ethnobiological knowledge about the Navajo sedge into its federal species recovery plan (House in Nabhan et al., 1991), acknowledging that Diné herders had been stewards of this plant's habitat for decades and deserved to participate in further efforts to safeguard the sedge.

In addition to their role as habitat managers, some cultural communities on the Colorado Plateau intentionally protect rare species, as is the case

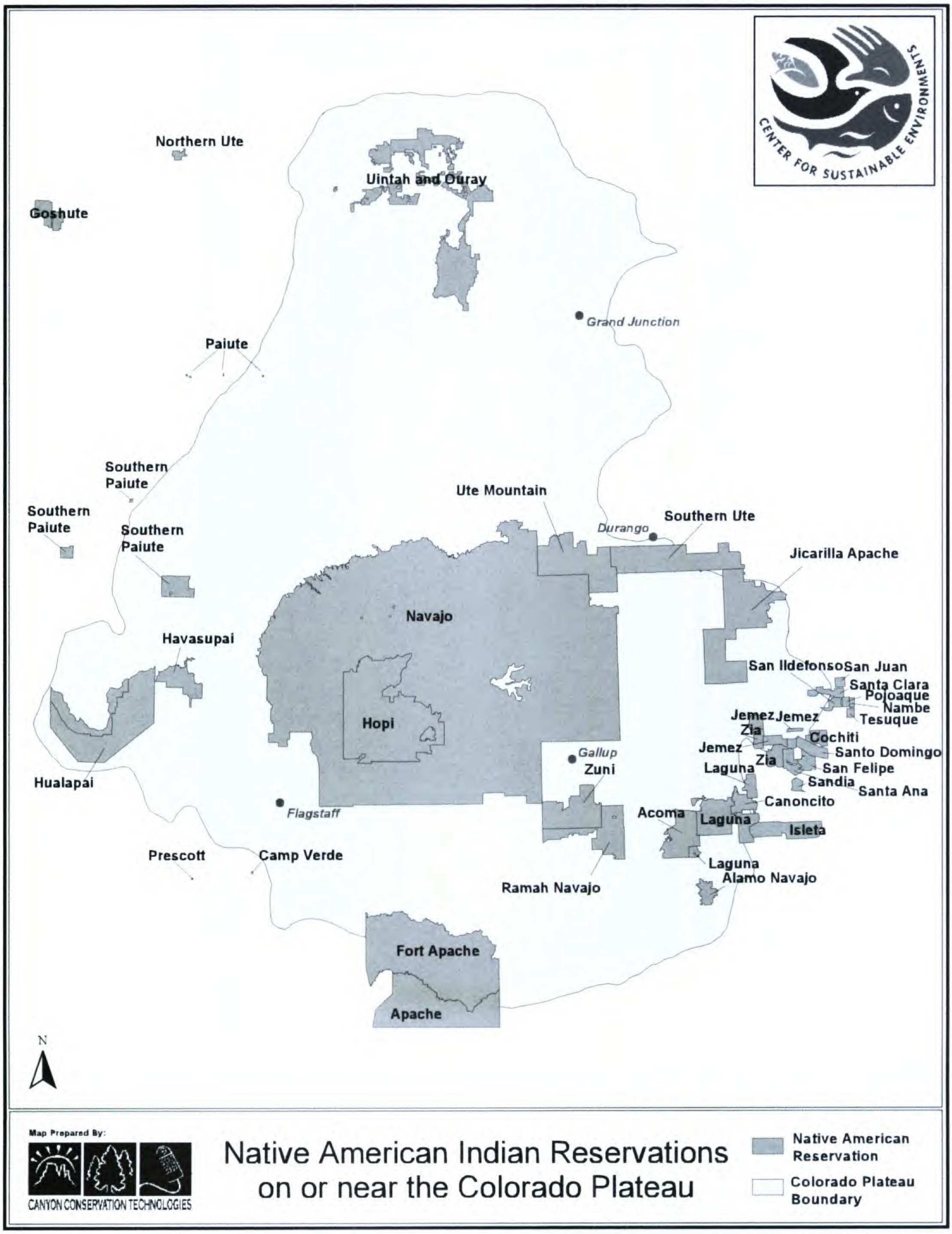

Figure 3. Native American Indian Reservations on or near the Colorado Plateau.

with the anomalous sunflower (*Helianthus anomalus* S. F. Blake). Of the twenty-five known localities for this species, at least seven are in or adjacent to Hopi fields and kivas, where farmers and priests spare it from their otherwise rigorous weeding practices (Nabhan & Reichhardt, 1983). Its flowers may be the sole source of a ceremonial facepaint prepared for the *Lakon mana* (maiden) ceremonies of early fall, so that these sunflower populations are protected as a necessity for fulfilling spiritual ob-

flaws associated with such an agenda, the most serious being that most hotspots are not only inhabited by diverse cultures, but they are also not for sale. By the mid 1990s prominent ethnobiologists, anthropologists, linguists, and biogeographers had brought attention to the fact that the 10–20 richest biodiversity hotspots were also extremely rich in cultural diversity, which was typically defined in terms of the richness of extant indigenous languages (Harmon, 1995). For instance, Toledo (1994) observed that of the nine countries considered to have the highest species richness of mammals, six of these were also among the richest in indigenous language groups: Indonesia, Brazil, Mexico, Zaire, India, and Australia.

Three commentaries are typically offered to explain this correlation and to hypothesize its causes (as cited by various authors in Maffi, 2001):

- *Geographic determinism*: Both species and languages diversify in heterogeneous landscapes with formidable geographic barriers.
- *Ecological determinism*: Linguistic diversification occurs in response to high biodiversity, as different cultural groups explore diverse ecological niches for themselves and encode their knowledge of rich biotas in different ways.
- *Historic determinism*: Areas of high linguistic diversity today are "residual," persisting because of their geographical isolation from extensive agricultural development (implying that now-impoverished areas were once more diverse).

Clearly, our Colorado Plateau pilot study reiterates a pattern seen on other continents as well: where hotspots of biodiversity or endemism are inhabited by a diversity of cultures, the ways in which these cultures encode traditional ecological knowledge about species in their native languages has tremendous potential for helping to conserve this biodiversity (Nabhan, 2000b). From this frequently observed correlation, several management implications must be considered:

- It may not be feasible or even advisable for government or non-government organizations (NGOs) to purchase the lands within these hotspots for biodiversity protection, because much of the biologically diverse area may be "common lands" held in trust by these cultural communities, such that they cannot be purchased, traded, or condemned. New efforts to conserve biodiversity elsewhere in the world need not make the same mistake the National Park Service historically made on the Colorado Plateau, by stealing, condemning, or finagling the rights to species-rich lands held in trust for future generations of indigenous peoples (Burnham, 2000).
- It is probable that for such high levels of biodiversity to persist in any hotspot until this day, indigenous residents consciously or unconsciously developed active and passive means of managing particular landscapes, microhabitats, or species guilds to maintain them. The potential utility of such knowledge, skills, and practices is great (Nabhan, 2000b), so much so that species recovery teams and formal land managers should be encouraged to integrate such knowledge into their conservation management plans (Tuxill & Nabhan, 1998).
- It is likely that proponents of biodiversity conservation will forge stronger, more effective collaborations with indigenous residents in biodiversity hotspots if they listen to and respect indigenous concerns about sovereignty, cultural property rights, and secrets associated with esoteric beliefs and ceremonies. Conservationists should attempt to collaborate on community-based projects that foster the continued oral transmission of traditional ecological knowledge, the persistence of indigenous languages, traditional subsistence or ceremonial practices, and the generation of health benefits or income for a broad cross section of community members. While such community-based conservation efforts are already given lip service from governments and NGOs alike, there remains a disproportionate investment in "top-down" conservation strategies and only scattered investment in community-based "bottom-up" strategies for maintaining biodiversity.
- Given the fact that traditional ecological knowledge about landscape-level biodiversity itself is being diminished (Berkes, 2000), the fragile relationship between the two needs to be more tangibly explored. While many biogeographers and linguists are already involved in efforts to understand global patterns of biodiversity and cultural diversity, it is hoped that our pilot project to safeguard the uniqueness of the Colorado Plateau will encourage other community-based practitioners to experiment with more practical means of integrating indigenous knowledge into collaborative efforts to conserve the world's hotspots of diversity and endemism.

Literature Cited

Agnon, S. Y. 1966. Editorial commentary. The Observer 5(1): 6.

Albert, S. & T. Trimble. 2000. Beavers are partners in

riparian restoration on the Zuni Indian reservation. Ecol. Restoration 18(2): 87–96.

Armstrong, D. M. in prep. Endemism in mammals of the Colorado Plateau. Draft analysis in preparation by the author, Department of Environmental, Population and Organism Biology, University of Colorado, Boulder, Colorado.

*Benson, Gloria. Paiute Tribe of Utah. Telephone interview. 12 December 2000.

Berkes, F. 2000. Sacred Ecology. Yale Univ. Press, New Haven.

Burnham, P. 2000. Indian Country, God's Country: Native Americans and the National Parks. Island Press, Washington, D.C.

*Campbell, L. 1997. American Indian Languages: The Historical Linguistics of Native America. Oxford Univ. Press, New York.

Cantoni, G. (editor). 1996. Stabilizing Indigenous Languages. Northern Arizona University Center for Excellence in Education, Monograph Series, Flagstaff, Arizona.

*Cuch, Mariah. Ute Tribe Public Relations. P.O. Box 400, Ft. Duchesne, Utah 84026. Electronic mail correspondence, 27, 29 December 2000.

Diamond, J. 1993. The Third Chimpanzee. W. W. Norton, New York.

Ehrenfeld, D. In press. Hot Spots and the Globalization of Conservation. Oxford Univ. Press, Oxford.

English, N. B., J. L. Betancourt, J. S. Dean & J. Quade. 2001. Strontium isotopes reveal distant sources of architectural timber in Chaco Canyon, New Mexico. Proc. Natl. Acad. Sci. 98: 11891–11896.

*Eriacho, Wilfred. Bilingual Specialist, Zuni Public Schools. Personal interview. 17 November 2000. Zuni Pueblo, New Mexico.

*Estes, James. October 1999. "How Many Indigenous Languages Are Spoken in the United States? By How Many Speakers?" National Clearinghouse for Bilingual Education. ⟨http://www.ncbe.gwu.edu/askncbe/faqs/20natlang.htm⟩

Gadgil, M. 1987. Diversity: Cultural and biological. Trends Ecol. Evol. 2(12): 369–373.

*Gallegos, Estrella. Culture and Language Department. Ute Mountain Ute Tribe. Telephone interview. 1 November 2000.

*Glassco, Greg. Cultural Resources Office, Hualapai Tribe. Peach Springs, Arizona. Telephone interview. 12 December 2000.

*Grimes, B. 1996. Ethnologue: Languages of the World. Dallas: SIL International, updated February 1999 at ⟨http://www.sil.org/ethnologue⟩

Harmon, D. 1995. The status of the world's languages as reported in *Ethnologue*. Southwest J. Linguistics 14: 1–28.

Hecox, W. E. & B. L. Ack. 1996. Charting the Colorado Plateau: An Economic and Demographic Exploration. Grand Canyon Trust, Flagstaff, Arizona.

*Hussey, Jennifer. Assistant Director, Paiute Tribe of Utah Language Department. Cedar City, Utah. Telephone interview. 20 December 2001.

Kartesz, J. & A. Farstad. 1999. Multi-scale analysis of endemism of vascular plant species. Pp. 51–55 *in* T. H. Ricketts, E. Dinerstein, D. M. Olson & C. Loucks, Terrestrial Ecoregions of North America: A Conservation Assessment. Island Press, Washington, D.C.

*Krauss, Michael. 1996. Status of Native American Language Endangerment. Pp. 16–21 *in* G. Cantoni (editor), Stabilizing Indigenous Languages. Center for Excellence in Education, Northern Arizona University, Flagstaff.

Maffi, L. 2001. On Biocultural Diversity. Smithsonian University Press, Washington, D.C.

Mittermeier, R. A., N. Myers, J. G. Thomsen, G. A. b. Da Fonseca & S. Olivieri. 1998. Biodiversity hotspots and major tropical wilderness areas: Approaches to setting conservation priorities. Conservation Biol. 12: 516–520.

Nabhan, G. P. 2000a. Interspecific relationships affecting endangered species recognized by O'odham and Comcaac cultures. Ecol. Appl. 10: 1288–1295.

———. 2000b. The Colorado Plateau as a center of diversity. Biodiversity Newsletter, The Consultative Group on Biological Diversity, San Francisco.

——— & K. L. Reichhardt. 1983. Hopi protection of *Helianthus anomalus*, a rare sunflower. SouthW. Naturalist 28: 231–236.

———, D. House, H. Suzan, W. Hodgson, L. Hernandez & G. Malda. 1991. Conservation and use of rare plants by traditional cultures of the U.S./Mexico borderlands. Pp. 127–146 *in* M. Oldfield & J. Alcorn (editors), Biodiversity: Culture, Conservation and Ecodevelopment. Westview Press, Boulder, Colorado.

*Naranjo, Dorothy. Cultural Preservation Office, Southern Ute Tribe. Ignacio, Colorado. Telephone interview. 12 December 2000.

Olson, D. M. & E. Dinerstein. 1998. The Global 2000: A representation approach to conserving the world's most biologically valuable ecoregions. Conservation Biol. 12: 516–520.

*Pino, Jackson. Middle School and High School teacher. Alamo Navajo Community, Alamo, New Mexico. Telephone interview. 15 November 2000.

*Polacca, Mary. Office of Hopi Tribal Enrollment. Telephone interview. 10 December 2000.

*Poleahla, Anita. Office of Hopi Cultural Preservation. Telephone interview. 10 December 2000.

Rea, A. M. 1981. California Condor captive breeding: A recovery proposal. Environm. SouthW. 492: 8–12.

Ricketts, T. H., E. Dinerstein, D. M. Olson & C. Loucks. 1999a. Who's where in North America? BioScience 49: 369–381.

———, ———, ——— & ———. 1999b. Terrestrial Ecoregions of North America: A Conservation Assessment. Island Press, Washington, D.C.

*Rollo, Gail. Tribal Administrator. Paiute Tribe of Utah. Telephone interview. 11 September 2000.

*Salari, Nasim. Program Coordinator, San Juan Southern Paiute Tribe. Telephone interview. 11 September 2000.

*Sandoval, Merton. Cultural Preservation Department. Jicarilla Apache Nation. Dulce, New Mexico. Telephone interview. 13 November 2000.

*Saunders, Vanessa. Tribal Secretary, Tonto Apache Tribe. Payson, Arizona. Telephone interview. 11 September 2000.

Seaman, P. D. 1993. Users Guide and Index for the A. f. Whiting Collection. Northern Arizona Anthropological Paper 1, Flagstaff.

*Secatero, Tony. President of Tohajilee (Canoncito Navajo). Telephone interview. 23 October 2000.

*All references denoted with an asterisk are sources (including all web sites shown) that were used to construct Table 3.

Sellars, R. W. 1997. Preserving Nature in the National Parks: A History. Yale Univ. Press, New Haven.

*Smith, Joni. Administrative Assistant. Camp Verde Yavapai-Apache Tribe. Telephone interview. 11 September 2000.

Stein, B. A., L. S. Kutner & J. S. Adams. 2000. Precious Heritage: The Status of Biodiversity in the United States. Oxford Univ. Press, Oxford.

*Tohtsoni, Nathan. "Who is a Navajo?" Navajo Times. 31 August 2000: 1.

Toledo, V. M. 1994. Biodiversity and cultural diversity in Mexico. Different Drummers: Incentives for Protecting North American Biodiversity 1: 16–19.

Tuxill, J. & G. P. Nabhan. 1998. Plants and Protected Areas. World Wildlife Fund Plants and People Manual. Stanley Thornes Publishing, Cheltenham, U.K.

*Vital Affairs Office. White Mountain Apache Nation. Whiteriver, Arizona. Telephone interview. 13 November 2000. Also ⟨http://primenet.com⟩ (landbase information).

*Wemytewa, Edward. Zuni Department of Game and Fish. Telephone interview. 11 September 2000.

Wilkinson, C. 1999. Fire on the Plateau: Conflict and Endurance in the American Southwest. Island Press, Washington, D.C.

*Willis, Lornene. Director of Cultural Center, Jicarilla Apache Nation. Dulce, New Mexico. Telephone interview. 13 November 2000.

*Yavapai Prescott Indian Tribe (brochure). The Yavapai Prescott Indian Tribe, 530 E. Merritt, Prescott, Arizona 86301, U.S.A.

*Web Sites Consulted
(Unless otherwise noted, all web sites listed below were accessed during December 2000 or January 2001)

⟨http://www.itcaonline.com⟩ [Havasupai, Hualapai, Hopi, Kaibab Band of Paiute Indians, Yavapai Prescott Tribe]
⟨http://www.carizona.com⟩ [Camp Verde Yavapai-Apache]
⟨http://www.yavapai-apache-nation.com⟩ [Camp Verde Yavapai-Apache]
⟨http://www.dced.state.ut.us/indian⟩ [Paiute Tribe of Utah]
⟨http://www.southern-ute.nsn.us/government/language.html⟩ [Southern Ute Tribe]
⟨http://www.ubtanet.com/~northernute⟩ [Northern Ute tribe]
⟨http://www.dced.state.ut.us/indian/Today/ute.html⟩ [Northern Ute tribe]
⟨http://epa.gov⟩ [Pueblo of Acoma]
⟨http://www.zuni.k12.nm.us⟩ [Zuni Pueblo]
⟨http://www.swr-hq.nm.bia.gov/ACRES-19.99.htm⟩ [Bureau of Indian Affairs: "Southwest Region Indian Acreages, As of 31 December 1999"]
⟨http://www.swr.-hq.nm.bia.gov/99ABQlf.htm⟩ [Bureau of Indian Affairs: "Southwest Region Combined Totals"]
⟨http://www.indigenous-language.org⟩ [Indigenous Languages Institute, Santa Fe, New Mexico: "Endangered Languages Database." Accessed 5 December 2001]